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Technology and Skill Demand in Mexico

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Abstract

López-Acevedo investigates the effects of technology on the employment and wages of differently skilled Mexican manufacturing workers using firm panel data from 1992–99. She analyzes the relationship between technology and skill demand. Findings support the skill-biased technical change hypothesis. She then examines the temporal relationship of technology adoption to firm productivity and worker wages. The author finds that skilled labor increases after technology adoption. And wages of both skilled and semi-skilled workers exhibit markedly increased growth rates compared with the growth rate of low-skilled workers. The results show that investment in human capital improves technology-driven productivity gains.

This paper—a product of the Latin America and the Caribbean Region, Poverty Reduction and Economic Management Sector Unit—is part of a larger effort in the region to reduce poverty and inequality through human capital investment. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Michael Geller, room I4-046, telephone 202-458-5155, fax 202-522-2111, email address mgeller@worldbank.org. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at gacevedo@worldbank.org. February 2002. (22 pages)

Mexico – Technology, Wages, and Employment

TECHNOLOGY AND SKILL DEMAND IN MEXICO

Gladys López-Acevedo[1]

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1. Introduction

In the mid-1980s, Mexico began a process of structural reform that fundamentally changed the economic environment facing productive enterprises. Liberalization began in 1984 and accelerated when Mexico joined the General Agreement on Tariffs and Trade in 1986. In 1989, the government began radical policy reforms to reduce government regulation and liberalize trade. The adoption of the North American Free Trade Agreement with the U.S. and Canada in 1994 intensified liberalization. These reforms replaced quotas with smaller tariffs, eliminated price ceilings and floors, simplified trade regulation, eased foreign direct investment restriction, and privatized state-owned enterprises.

Because of this international openness, technology now lies at the heart of Mexican economic activity. Globalization-induced competition has made firms increase the speed and efficiency of new technology adoption (TA). It has also inspired firms to increase research and development (R&D) budgets (OECD 2000).

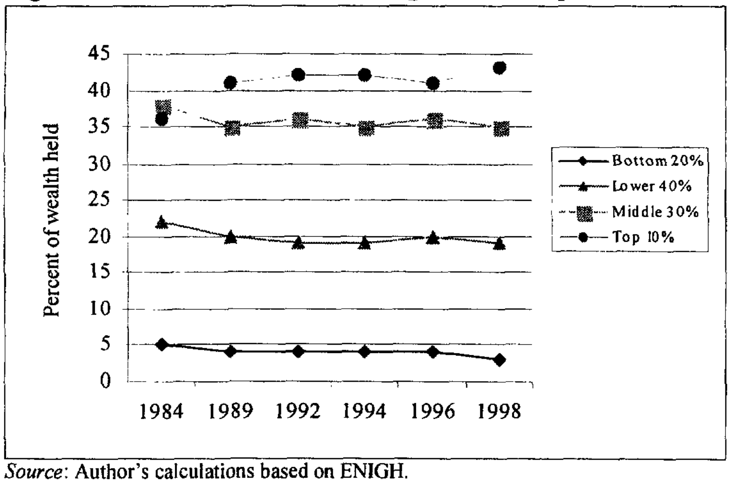
However, liberalization has worsened Mexican wage equality (World Bank 2000). The Gini coefficient, which measures income inequality and is especially sensitive to changes around the population median, rose from 0.47 in 1984 to 0.53 in 1998 (Table 1). While the poorest quintile lost 1.3 percent of its income during this period, the richest decile increased its wealth by 7.7 percent. In relative terms, all strata except the richest lost income during this period (Figure 1).

Table 1. Inequality in Mexico, Measured by Gini Coefficient

Year	National	Urban	Rural
1984	0.47	0.44	0.45
1989	0.52	0.50	0.44
1992	0.53	0.50	0.43
1994	0.53	0.51	0.42
1996	0.52	0.49	0.45
1998	0.53	0.495	0.48

Source: Author's calculations based on ENIGH.

Figure 1. Wealth Distribution among Mexican Population



Source: Author's calculations based on ENIGH.

At the height of liberalization, Mexico underwent a severe currency crisis. In December 1994, Mexico sharply devalued the peso causing a deep economic recession. In 1995, real gross domestic product (GDP) fell by 6.2 percent, demand fell by 14.4 percent, and investment fell by 43 percent. This market contraction shifted trade as exports increased by almost 31 percent and imports fell by 9 percent. Nevertheless, a cheap peso bolstered exports and offered new markets to firms whose domestic sales had collapsed. Domestic demand quickly recovered, and by 1997 real GDP had returned to its pre-crisis level.

This paper investigates the skill-biased technological change (SBTC) hypothesis for Mexico, using panel data from the National Survey of Employment, Salaries, Technology, and Training (ENESTYC) and the Annual Industry Survey (EIA). The panel has observations for 1992, 1995, and 1999 (for a description of these surveys and the panel see Appendix A and B, and for a list of variables Appendix C).

Section 2 reviews Mexico-specific circumstances. Section 3 asks whether technological change is biased towards particular skill groups. Section 4 analyzes the relationship of skilled labor employment to the use of technology. Section 5 discusses productivity gains from TA and training. Section 6 presents conclusions.

2. Literature Review

A key implication of technology diffusion is its impact on the labor market. Several studies (Davis and Haltiwanger 1991; Krueger 1993, and Mincer 1991) find that technology has raised the relative demand for more skilled workers and, consequently, reduced the demand for manual labor. Katz and Murphy (1992) use a basic supply and demand approach to show that relative labor demand shifts come from intra-industry changes (such as factor non-neutral technological change, changes in prices of non-labor inputs, and outsourcing) and inter-industry changes (such as shifts in market-wide product demand, sector differences in factor-neutral total factor productivity (TFP) growth, and trade shifts that change the domestic share of output at fixed relative wages). Aw and Batra (1999) also provide evidence that technology (measured by R&D and by worker training) has an impact on firm performance (measured by wages). This finding coheres with the World Bank (1999) "Mexican Labor Markets: New Views on Integration and Flexibility," which relates wages to technology (measured in terms of R&D and technology acquisition).

In the last decade, Mexican wage inequality has increased sharply. Three theories – the liberalization hypothesis, the labor institution hypothesis, and the SBTC hypothesis – can explain this increase in earnings inequality in Mexico.[2] The liberalization hypothesis argues that reduced trade barriers put an economy under competitive pressure to specialize along its lines of comparative advantage. A developed country with high levels of human capital will shift to advanced industry and services as low-skilled industries feel competition from countries with abundant low-wage workers.

In a test of liberalization theory, Hanson and Harrison (1995) examine the impact of Mexican trade reform on wage structure using firm-level data. They test whether trade reform shifted employment toward skilled labor-intensive industries (the Stolper–Samuelson-Type [SST] effect). They conclude that changes within industries and firms caused the wage gap, and

[2] See, for example, the "Symposium on Wage Inequality" (1997) and the "Symposium on How International Exchange, Technology and Institutions Affect Workers" (1997).

that the SST effect provides a poor explanation. Thus the increase in wage inequality was due to other factors. Burfisher and others (1993) also examine the SST effect under NAFTA.

However, the liberalization hypothesis seems ill-fitted to the Mexican experience. Mexico began lowering trade barriers after 1984, particularly for American and Canadian commerce, whose share of merchandise imports from Mexico increased from 68 percent in 1985 to 78 percent in 1996. Since Mexico has an abundant supply of low skilled labor relative to its northern neighbors, the liberalization hypothesis predicts that lowered trade barriers would raise both the wages and the demand for unskilled labor in Mexico. However, as trade barriers fell, low-skilled labor in Mexico experienced a real wage decrease while skilled labor had a real wage increase, resulting in worsened wage inequality.

The trade theory can be adjusted to fit Mexico better: while trade liberalization pushes a country towards its comparative advantage, it also facilitates the transfer of ideas and technology. This seems to provide a better explanation of earnings inequality. Feenstra and Hanson (1996) put forward a variant of the liberalization hypothesis that involves outsourcing whereby multinational enterprises in the developed country relocate their less skill-intensive activities to the less skill-abundant developed countries. However, what is referred to as a low-skill activity in the United States may be a high-skill activity in Mexico, which could explain the similarity in earnings inequality between the two countries.

The institutional hypothesis considers broad changes such as minimum wage reductions and weakened trade unions. A binding minimum wage truncates the lower end of the wage distribution. As the real minimum wage decreases due to inflation, its effect on industry also decreases. This translates into increased wage and earnings dispersion. Since the early 1980s, institutional developments have exerted insignificant influence on earnings distribution. The distribution of real wages, for example, reveals little distortion due to the minimum wage, which suggests that the minimum wage is low enough to affect industry minimally. Similarly, union wages in Mexico are similar to nonunion wages, controlling for education differences. This data suggests that unions have little or no impact on earnings. Although we cannot entirely reject the institutional hypothesis, it does not appear to be the principal explanation for Mexican earnings inequality.

The SBTC hypothesis links earnings inequality to technology that raises relative demand for skilled labor. Cragg and Epelbaum (1996) find that, given different labor supply elasticities, the primary source of Mexican wage inequality is a skill-biased demand shift rather than skill-uniform demand growth. Meza (1999) also investigates the Mexican labor market, and finds that intra-industry demand shifts toward a more educated labor force explain unskilled labor wage decreases better than interindustry demand shifts. The World Bank (2000) also shows that demand increases for a more educated labor force within the economic sectors explain the increase in their premium when compared to the demand shifts for less educated workers between economic sectors. Acosta and Montes (2001) show that there is a constant increase on skill premia during the 1987-1993 period, but there is a deceleration during the 1994-99 period and a decline after 1997. These authors contend that the former may be caused by between industry differences.

Batra and Tan (1997) study the SBTC hypothesis as a plausible explanation of wage inequality using firm-level data for Colombia, Mexico, and Taiwan (China). They find that technology's impact on wages is greatest for skilled workers and lowest for unskilled workers, thereby supporting the SBTC hypothesis. In this hypothesis, skilled workers become more efficient in jobs traditionally performed by unskilled workers (Johnson 1997).

3. Technology's influence on wages and employment

To determine whether the technology of Mexican firms influences their skill demand, we estimate determinants of each skill group's share of total wages. In this fixed-effects model, we use a modified first-differencing to eliminate firm-specific error. For a cost minimizing firm, the following equation models technology's influence on wages:

$$\ddot{W}_{jit} = \beta_1 \ln \ddot{V}A_{it} + \beta_2 \ln \ddot{K}_{it} + \beta_3 \ln \ddot{R}_{it} + \beta_4 \ln \ddot{T}FP_{it} + \beta_5 \ln \ddot{U}R_t + \ddot{\varepsilon}_{it} \quad (1)$$

where:

$\ddot{W}_{it}$ = $W_{it} - \overline{W}_i$, or the wages of firm i at time t minus the average wages of firm i over all time periods;
W_{ji} = the wage share of skill-group j in the total wages of firm i;
VA = value-added (calculated with INEGI's methodology, i.e. the difference between the value of the production of the firm and its expenditure in materials, water, energy and electricity) in real 1997 pesos;
K = capital assets not deflated;[3]
R = the relative wage of skilled workers in relation to unskilled workers;
TFP = total factor productivity, a measure of technological change;
UR = the unemployment rate, included as a control for macroeconomic shocks, and
ε = the normal regression error.

A positive β_1 parameter in equation (1) indicates that growing industries are more likely to increase the wages of skill group j. A positive β_2 parameter indicates that capital and skills are complementary inputs in the production process; a negative parameter indicates that capital and skills are substitutes. The β_3 parameter indicates how changes in relative wages affect the wages of skill group s. We expect this parameter to be negative, since a rise in the relative wages of one skill group leads a cost-minimizing employer to substitute towards other groups. The β_4 parameter of the TFP shows the extent to which technological change is skill-biased. If TFP is skill-neutral, it should not impact skill mix. A positive β_4 parameter implies that technological change is skill-using or skill-biased, while a negative β_4 indicates that technology is skill-replacing. Finally, β_5 will indicate us how the employment of the different skill groups varies as unemployment changes.

We estimate TFP as the residual in a production function. The specification of the Cobb-Douglas production function is:

$$\ln(VA)_{it} = \beta_1 \ln(K)_{it} + \beta_2 \ln(L)_{it} + \varepsilon_{it} \qquad (2)$$

where:

VA = value-added, in real 1997 Mexican pesos;
K = fixed capital assets, not deflated;
L = labor inputs, total hours worked per annum;
ε_{it} = the normal regression error;
i = the individual plant being analyzed, and

[3] No deflator is available for fixed assets, due to this we assume that the flow of capital services is adequately reflected in its book value.

t = the time period.

We estimate equation (1) for 1992-99 manufacturing firms panel using a fixed-effects model. Tables 2 and 3 give separate results for wages and employment shares of skill groups, so we can use both to measure skill demand.

Table 2. Wage Determinants, by Employee Skill Group

Dependent variable:	Highly skilled			Semi-skilled			Low skilled		
Share of wages	**Coeff.**		**t-Stat.**	**Coeff.**		**t-Stat.**	**Coeff.**		**t-Stat.**
Value-added	-0.0647	**	-4.161	0.0281	**	1.966	0.0365	**	3.241
Capital assets	0.0479	**	5.794	-0.0401	**	-5.270	-0.0078		-1.301
Wage ratio s/us	0.0082	**	2.061	0.1204	**	32.757	-0.1286	**	-44.456
TFP	0.0232	**	3.864	-0.0148	**	-2.681	-0.0084	*	-1.926
Unemployment rate	-0.0225	**	-2.636	0.0146	*	1.850	0.0080		1.285
Overall R^2	0.0315			0.4550			0.5508		

* Significant at 10% level; ** Significant at 5% level.

Notes: 1. Number of observations = 1,185.

2. Regressions included indicator variables for 9 manufacturing divisions.

3. Share of wages is the share of the firm's total wages paid to workers of a particular skill level.

Table 3. Employment Determinants, by Employee Skill Group

Dependent variable:	Highly Skilled			Semi-skilled			Low skilled		
Share of Employment	**Coeff.**		**t-Stat.**	**Coeff.**		**t-Stat.**	**Coeff.**		**t-Stat.**
All Employees									
Value-added	-0.8129	**	-2.487	1.1669		0.687	-0.3552		-0.210
Capital assets	0.7198	**	4.140	-1.1942		-1.321	0.4785		0.531
Wage ratio s/us	0.0704		0.837	14.9349	**	34.190	-15.0057	**	-34.455
TFP	0.3072	**	2.428	-0.5728		-0.871	0.2653		0.404
Unemployment rate	-0.0458		-0.255	3.3348	**	3.566	-3.2807	**	-3.518
Overall R^2	0.0037			0.5869			0.5887		
Male Employees									
Value-added	-0.0076	*	-1.895	0.0412	*	1.735	-0.0210		-0.825
Capital assets	0.0077	**	2.826	-0.0277	*	-1.714	0.0088		0.510
Wage ratio s/us	0.0007		0.671	0.1335	**	20.184	-0.1392	**	-19.679
TFP	0.0042	**	2.946	-0.0216	**	-2.527	0.0105		1.147
Unemployment rate	0.0008		0.084	0.0447		0.819	-0.0713		-1.221
Overall R^2	0.0081			0.4319			0.3658		
Female Employees									
Value-added	-0.0013		-1.193	-0.0340	**	-2.045	0.0226		1.499
Capital assets	0.0011		1.541	0.0252	**	2.234	-0.0151		-1.480
Wage ratio s/us	0.0003		1.051	0.0275	**	5.945	-0.0228	**	-5.435
TFP	0.0007	*	1.831	0.0094		1.565	-0.0032		-0.588
Unemployment rate	-0.0022		-0.900	0.0341		0.894	-0.0061		-0.175
Overall R^2	0.0145			0.0057			0.0353		

* Significant at 10% level; ** Significant at 5% level.

Notes: 1. Number of observations = 1,185.

2. Regressions included indicator variables for 9 manufacturing divisions.

3. Share of employment is the share of the firm's total employment held by workers of a particular skill level.

The effects of output growth vary between skill groups. It appears that growing firms are less likely to hire highly skilled male employees. In contrast, for the semi-skilled group and the low skilled group, the value-added parameters are positive and significant in the wage share estimation and insignificant in the employment share specification for all workers. With reference to gender, the value-added parameter is positive for the semi-skilled male workers and negative for the semi-skilled female workers, this suggests that growing firms tend to increase male rather than female production workers.

It is interesting to note that the unemployment control is positive for the semi-skilled group and negative or neutral for the highly skilled and low-skilled groups. This suggests that employers increase the relative share of production workers as overall unemployment rises.

We find that capital and highly skilled workers are complements while capital and semi-skilled workers are substitutes. This result is consistent with Tan (2000). Also, capital and semi-skilled male production workers are substitutes while capital and semi-skilled female production workers are complements.

Finally, technology is biased toward the use of highly skilled workers. This implies that technology is skill-using for highly skilled workers but skill-replacing for semi-skilled and unskilled workers. Furthermore, technical change is skill-using for male and female highly skilled workers and skill-replacing for the semi-skilled male production workers. Tan (2000) finds that, in Malaysia, technical change is skill-using only for male highly skilled workers.

4. Time of benefit from technology

Probit models of technology adoption are informative but ill-suited to dynamic processes (López-Acevedo 2001). To analyze the temporal relationship of labor demand and TA, we use event analysis. As Tan (2000) suggests, comparing the period of TA to skill-mix changes in previous and consecutive time periods facilitates effective event analysis. The variable τ represents the time period relative to TA; the period of adoption is $\tau = 0$, the period preceding adoption is $\tau = -1$, and the period following adoption is $\tau = 1$. Since companies adopt technology at different times, the period in which $\tau = 0$ differs between firms. Also, we define that $\tau = 0$ in all periods for a firm that never adopts technology. Since we only have point data for 1992, 1995, and 1999, τ ranges from –2 to 2. Using information on τ from all firms that adopt technology, we estimate the *τ-profile* of skill shares, or the relationship of when a firm hires skilled labor to when it adopts technology. We measure the τ-profile relative to $\tau = 0$ to allow comparison with firms that adopted technology in the same period, and with firms that never adopted technology.

We want to know how employers vary skill-mix in the years preceding and following TA. A regression model relating skill shares to τ may be written as follows:

$$S_{ijt} = \beta_0 + \beta_1 X_{it} + \beta_2 \Sigma_\tau Z_{ijt} + \beta_3 T_t + \beta_4 \ln UR + \varepsilon_{it} \qquad (3)$$

where:

S_{ijt}	= the share of workers of skill group j in firm i during period t;
X	= a vector of firm and industry characteristics;
Z	= a vector of dummy variables for each τ between –2 and +2;
T_t	= a time trend term, and
UR	= the unemployment rate, included as a control for macroeconomic changes.

Here, the β_2 coefficients trace the τ-profile of skill share j relative to $\tau = 0$. We use models of similar specification to examine how productivity and wages vary with τ.

Table 4 reports the estimated coefficients of τ, in relation to $\tau = 0$. These τ-profiles appear graphically in Figures 2 through 8. We fit these graphs with cubic spline to show the underlying trends in these variables over τ more effectively. In essence, they relate firm hiring patterns to TA timing.

Table 4. Estimated Coefficients of τ for Skill Shares, Productivity and Wages of TA Firms

	Skill Shares			Productivity	Wages by Skill Group		
τ	Highly skilled	Skilled and semi-skilled	Unskilled		Highly skilled	Skilled and semi-skilled	Unskilled
-2	-0.7193 *	-2.8499	3.8857	-1.0721 **	-1.3990 **	-1.1136 **	-0.9067**
-1	-0.5144 *	-7.6369**	9.0491 **	-0.5273 **	-0.7277 **	-0.7224 **	-0.3480**
0							
1	0.2992 *	3.2059**	-3.0640 **	0.5745 **	0.7215 **	0.6064 **	0.5846**
2	0.5262 **	3.0331**	-4.5258 **	1.0297 **	1.4301 **	1.1697 **	1.1401**

* Significant at 10% level; ** Significant at 5% level.

Notes: Regressions included dummy variables for 9 manufacturing divisions, indicators for small, medium and large firms, dummy variables for foreign firms and joint-ventures, and a control for macroeconomic changes.

Figure 2-4. Skill Shares Pre- and Post-TA Relative to Non-TA Firms

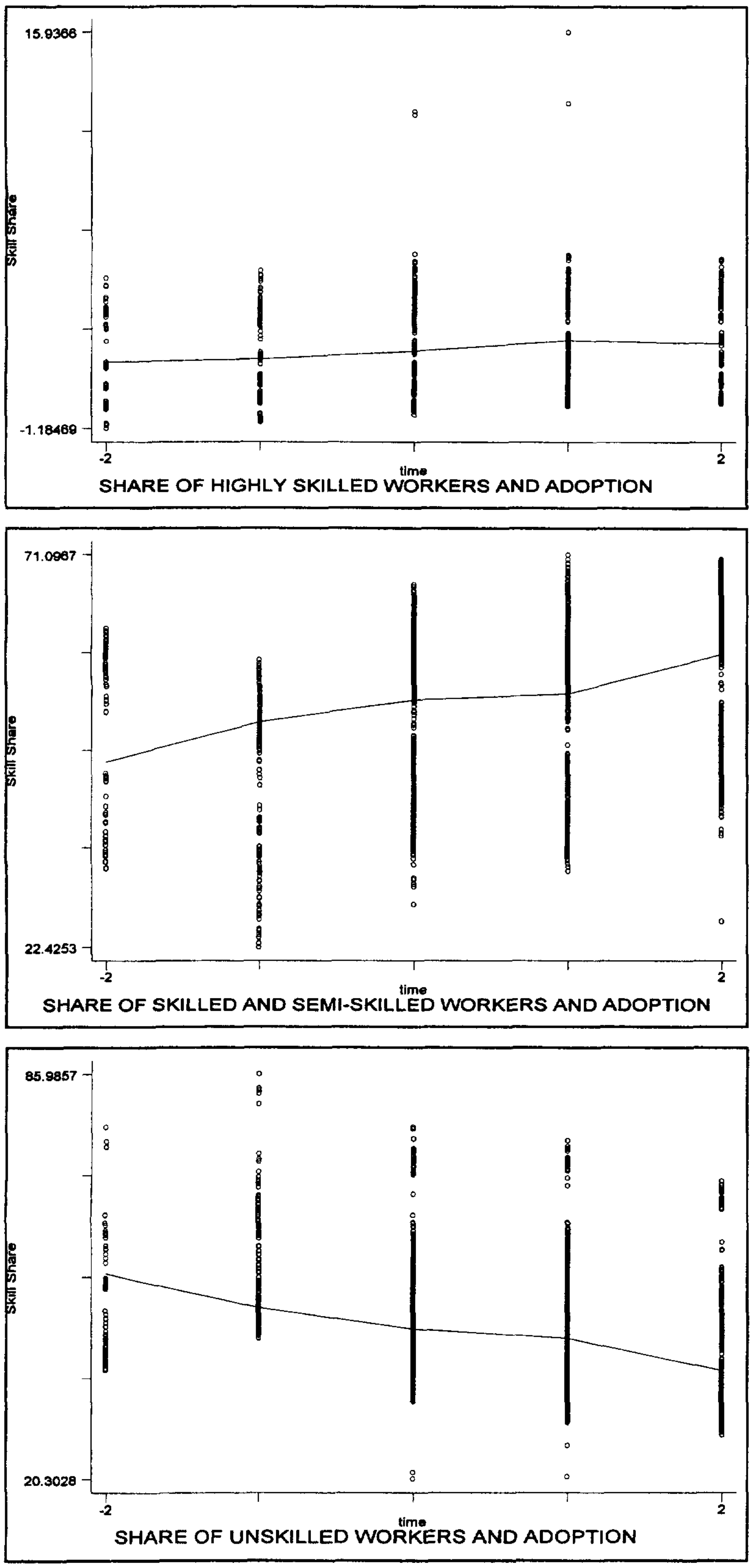
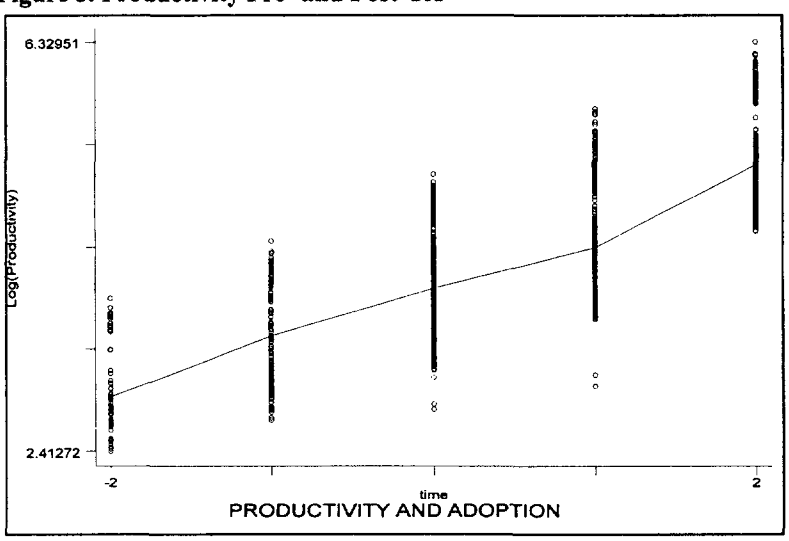


Figure 2 and Table 4 show that prior to TA, the share of highly skilled workers changes little relative to the time of TA. The share of highly skilled workers among total firm employment is fairly small. Although we observe an increase in the number of highly skilled workers hired after TA, the increase is also small relative to the total number of workers in the firm. Figure 3 shows that the share of skilled and semi-skilled production workers increases before and after TA. By the second period after TA, the share of skilled and semi-skilled workers has risen considerably. Figure 4 shows that the share of less-skilled workers is actually larger before TA, but falls post-adoption.

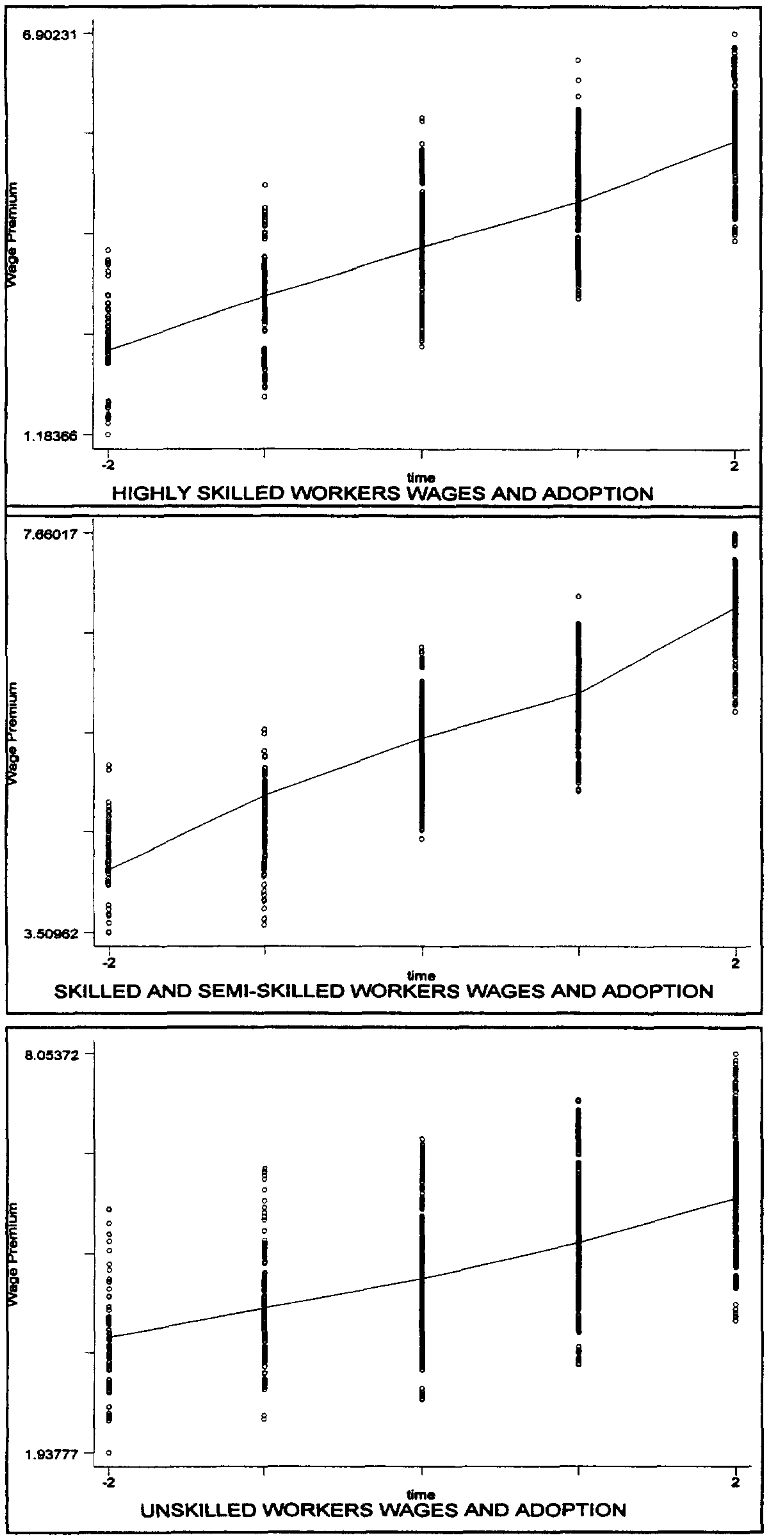
The τ-profile for productivity appears in Figure 5. Productivity of technology firms is relatively low before TA. But after TA, productivity of technology firms increases. Although the y-axis of the graph represents the log of productivity, the scale is linear and not logarithmic; hence, the productivity of technology firms increases both before and after TA. However, one period after TA, the rate of productivity growth jumps.

Figure 5. Productivity Pre- and Post-TA



Technology increases firm productivity and consequently firm profits. But how do worker wage changes relate to firm profit increases? To address this question, we estimate separate equations for each skill group, with the dependent variable being the logarithm of wages of the skill group. The resulting τ-profiles of three skill groups – highly skilled, semi-skilled, and low skilled workers – appear in Figures 6-8.

Figure 6-8. Wage Premiums by Skill Group Pre- and Post-TA



Wages show similar trends to productivity, as it appears that employers share productivity gains from technology with all skills of employees. However, skilled employees receive significantly more benefit than unskilled employees. Wages of all skills of employees begin rising two periods before TA, and continue rising until two periods after TA. Furthermore, the growth rates of the wages of all skill groups jump after TA.

5. Technology Adoption and Productivity Growth

As Tan (2000) argues, a production function including variables for technology type and experience with technology is the best approach for investigating formally the productivity gains from introduction of new technology. The production function also lets us test whether the benefits of experience with technology increase when combined with employee training:

$$\ln(\ddot{VA})_{it} = \beta_1 \ln(\ddot{K}_{it}) + \beta_2 \ln(\ddot{L}_{it}) + \beta_3 \Sigma_j \ddot{TA}_{it} + \beta_4 \Sigma \ddot{\gamma}_{it} + \beta_5 \ddot{Z}_{it} + \ddot{\varepsilon}_{it} \quad (4)$$

where:

$\ddot{VA}$	$= VA_{it} - \overline{VA}_i$, or the difference of VA at time t and the average of VA at all times for firm i.
VA	= value-added (calculated with INEGI's methodology, i.e. the difference between the value of the production of the firm and its expenditure in materials, water, energy and electricity) in real 1997 pesos;
K	= capital assets (not deflated);[4]
L	= labor input;
$\Sigma_j TA$	= a vector of interactive indicator variables for the j types of technology adopted;[5]
$\Sigma\gamma$	= a vector of indicator variables for technology experience;
Z	= a vector of firm and industry characteristics;
i	= firm under analysis;
t	= time period;
ε	= normal regression error.

To find the value-added of training when new technology is adopted, we include interaction terms for technology type and training. Robust results in Table 5 show that

[4] No deflator is available for fixed assets, due to this we assume that the flow of capital services is adequately reflected in its book value.

[5] This is a dummy variable that gets assigned a "1" if the firm adopts new technology and provides training, an a "0" otherwise.

combining training with TA increases productivity in three of the four categories of technology. On average, when training increases technology's productivity the benefit is more than six percent. These results indicate the importance of complementary investments in worker training to realize the productivity potential of technology. Training has the greatest effect when a firm adopts machinery tools, and the least effect when a firm adopts robots.

Table 5. The value-added of training with technology

Dependent variable: Log(value-added)	1992-1999 Coeff.		t-Stat.
Production Function			
Constant	9.1594	**	27.833
Log(capital)	0.0948	**	3.843
Log(total hours worked)	0.1378	**	5.224
Types of TA and Training			
Automatic equipment	0.0635	*	1.742
Machinery tools	0.0789	**	2.593
Computerized machinery	0.0671	*	1.684
Robots	-0.0041		0.976
TA Experience			
1	-0.1029	**	-3.864
2	-0.0081		0.817
Number of obs.	2,733		
Overall R^2	0.4143		

* Significant at 10% level; ** Significant at 5% level.

Note: Regressions included dummy variables for 9 manufacturing divisions, foreign firms and joint-ventures.

6. Conclusions

This paper attempts to understand how TA affects demand for highly skilled, skilled and semi-skilled, and unskilled workers. Both in terms of wages and employment, with TA firms tend to hire more high skilled workers and pay them better. We also analyze the relative times of TA and demand shifts for a given firm. We find that demand for highly skilled workers increases after the adoption of technology, but not before. By the second period after TA, demand for highly skilled, skilled, and semi-skilled workers has risen notably, while the share of employees made up of unskilled workers tends to diminish after the adoption of technology. Additionally, training and increases in human capital magnify technology-driven productivity gains.

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APPENDIX A

INEGI has compiled the National Survey of Employment, Salaries, Technology, and Training (ENESTYC). The Ministry of Labor co-designed the questionnaire, which gathered rich information on training, technology, wages, employment, forms of labor contracting, and internal plant organization of Mexican manufacturing firms. The government conducted the survey in 1992, 1995, and 1999, but its questions on technology ask whether the firm adopted technology in the periods 1989-1992, 1994-1995, or 1997-1999, respectively. Our references to the time of technology adoption mention only the final year of the period (e.g. 1992 rather than 1989-1992). Data from the 1992 survey includes 5,071 firms, from the 1995 survey includes 5,242 firms, and from the 1999 survey includes 7,429 firms.

A valuable feature of ENESTYC is that it allows us to identify the same firm in 1992, 1995, and 1999. Nonetheless, we should qualify our estimations with survivor bias. Only firms that exist in all three years can be included in the panel database. As Audretsch (1995) shows, survival likelihood is strikingly low for small and new enterprises and increases with firm size and age. Thus, the panel includes an unrepresentatively high number of large and mature firms. While random observation selection should not cause bias in our resulting estimations, surviving firms are not randomly selected. Darwinian selection of extant firms means that the firms in our sample tend to be more efficient and have better performance than an average Mexican firm.

Another advantage of this database is the broad spectrum of firm sizes included by industry, shown in tables B.1-B.3. The rich information available in ENESTYC allows us to distinguish technology diffusion policies for firms of different size and character.

INEGI also conducts the Annual Industrial Survey (EIA). The survey covers 6,500 manufacturing plants throughout Mexico that account for 80 percent of production in each industry group. Since the survey attempts to cover the majority of manufacturing production but not a majority of plants in all categories, our sample includes all large plants and most medium-sized scale plants, but few small-scale plants and very few microenterpise plants.

We link the ENESTYC panels to firms in the EIA. This allows us to combine EIA data on productivity, labor, value-added, and capital with ENESTYC variables for the plants common to both surveys. The panels also include some regional variables using the Indicators of Scientific and Technology Activity in Mexico from the National Council of Science and Technology (CONACYT). A description of the variables in the panels appears in the Appendix. The 1992-95 panel has 3,293 firms, the 1995-99 panel has 1,717 firms, and the 1992-99 panel has 1,066 firms.

The information on individual establishments that INEGI gathers through its questionnaires (which law requires firms to answer) is legally confidential, and INEGI is unable to give the raw data to outside agencies. Therefore, we followed an established procedure in which most data analysis was done in INEGI's Aguascalientes headquarters with the support of INEGI personnel. Nevertheless, the reader should bear in mind the limitations on data analysis imposed by this institutional arrangement.

APPENDIX B

Table B.1. Manufacturing Firms in the 1992-1995 Panel by Industry and Size

Division	All	Size: Large	Medium	Small	Micro
Total	**3,293**	**352**	**576**	**1,099**	**1,266**
Food, beverage and tobacco	669	105	114	163	287
Textiles, clothing, leather	551	36	93	231	191
Wood and wood products	149	28	42	61	18
Paper and paper products	219	16	31	103	69
Chemical products	494	40	94	185	175
Non-metallic minerals	161	45	31	25	60
Basic metal industries	102	13	13	39	37
Metal products, machinery	897	65	147	272	413
Other manufacturing industries	51	4	11	20	16

Source: 1992-95 ENESTYC Panel.

Table B.2. Manufacturing Firms in the 1995-1999 Panel by Industry and Size

Division	All	Size: Large	Medium	Small	Micro
Total	**1,717**	**829**	**737**	**145**	**6**
Food, beverage and tobacco	372	232	114	26	
Textiles, clothing, leather	273	133	113	23	4
Wood and wood products	57	19	32	6	
Paper and paper products	146	54	83	9	
Chemical products	306	126	153	26	1
Non-metallic minerals	75	32	33	10	
Basic metal industries	41	21	15	5	
Metal products, machinery	419	198	183	37	1
Other manufacturing industries	28	14	11	3	

Source: 1995-99 ENESTYC Panel.

Table B.3. Manufacturing Firms in the 1992-1999 Panel by Industry and Size

Division	All	Size: Large	Medium	Small	Micro
Total	1,066	554	439	72	1
Food, beverage and tobacco	227	154	63	10	
Textiles, clothing, leather	162	70	80	12	
Wood and wood products	36	9	19	8	
Paper and paper products	95	36	52	7	
Chemical products	190	86	87	16	1
Non-metallic minerals	46	34	10	2	
Basic metal industries	36	18	18		
Metal products, machinery	257	138	102	17	
Other manufacturing industries	17	9	8		

Source: 1992-99 ENESTYC Panel.

APPENDIX C

1992-99 Panel Variables Description

Variable	Description	Value
From the ENESTYC		
Firm size	Firm size according to the number of workers: Micro 1 - 15 Small 16 - 100 Medium 101 -250 Large 250 - more	Dummy for each size 1= if the firm belongs to a certain size 0= otherwise.
Division	Manufacturing industries: 1) Food, beverages, and tobacco 2) Textiles, clothing, and leather 3) Wood and wood products 4) Paper, paper products, printing, and publishing 5) Chemicals, oil derivatives, and coal 6) Non-metallic mineral products 7) Basic metallic industries 8) Metallic products, machinery, and equipment 9) Other manufacturing industries	Dummy for each industry 1= if the firm belongs to a certain industry 0= otherwise.
Total workers	Number of workers in the firm.	Continuous
Regions:		Dummies
North	Includes the states of Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Nuevo León, Sinaloa, Sonora, Tamaulipas, and Zacatecas.	1= if the firm is located in the North, 0= otherwise.
Center	Includes the states of: Aguascalientes, Colima, Guanajuato, Hidalgo, Jalisco, México, Michoacán, Morelos, Nayarit, Puebla, Querétaro, San Luis Potosí, and Tlaxcala.	1= if the firm is located in the Center, 0= otherwise.
South	Includes the states of Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán.	1= if the firm is located in the South, 0= otherwise.
Capital	Distrito Federal	1= if the firm is located in the Capital, 0= otherwise.
Years	Firm's age.	Continuous
Technology adoption	Adoption of new technology.	Dummy 1= if the firm adopts new technology, 0= otherwise.
Highly skilled workers	Number of executives and managers in the firm.	Continuous
Semi-skilled workers	Number of production workers in the firm.	Continuous
Unskilled workers	Number of general workers in the firm.	Continuous
Share of highly skilled workers	Share of highly skilled workers from the total of workers in the firm.	Ranks between 0-100
Share of semi-skilled workers	Share of semi-skilled workers from the total of workers in the firm.	Ranks between 0-100
Share of unskilled workers	Share of unskilled workers from the total of workers in the firm.	Ranks between 0-100
New hires	New hires.	Continuous
Laidoffs	Dismissals.	Continuous
Net employment	New hires less dismissals.	Continuous
Total wages	Total wages in real pesos paid in the firm.	Continuous
Highly skilled wages	Total wages in real pesos paid to the highly skilled workers in the firm.	Continuous
Semi-skilled wages	Total wages in real pesos paid to the semi-skilled workers in the firm.	Continuous

Unskilled wages	Total wages in real pesos paid to the unskilled workers in the firm.	Continuous
Share of highly skilled wages	Share of the highly skilled workers wages from the firm's total wages.	Ranks between 0-100
Share of semi-skilled wages	Share of the semi-skilled workers wages from the firm's total wages.	Ranks between 0-100
Share of unskilled wages	Share of the unskilled workers wages from the firm's total wages.	Ranks between 0-100
Maquila	Firms dedicated to maquila activities.	Dummy 1= if maquila 0= otherwise.
Productivity	Firm's productivity measured as output per worker.	Continuous
From the EIA		
Capital assets	Firm's capital: fixed assets, not deflated.	Continuous

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